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# American Public Health Association

## LOMB PRIZE ESSAY

# DISINFECTION AND INDIVIDUAL PROPHYLAXIS AGAINST INFECTIOUS DISEASES

By GEORGE M. STERNBERG, M. D.
*Major and Surgeon U. S. Army*

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# INTRODUCTION.

As the result of prizes offered by Mr. Henry Lomb, of Rochester, N. Y., through the American Public Health Association, the following awards were made at the last meeting of the association:

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| I. | HEALTHY HOMES AND FOODS FOR THE WORKING CLASSES. By VICTOR C. VAUGHAN, M. D., PH. D., Professor in University of Michigan. Prize, | $200 |
| II. | THE SANITARY CONDITIONS AND NECESSITIES OF SCHOOL-HOUSES AND SCHOOL-LIFE. By D. F. LINCOLN, M. D., Boston, Mass. Prize, | $200 |
| III. | DISINFECTION AND INDIVIDUAL PROPHYLAXIS AGAINST INFECTIOUS DISEASES. By GEORGE M. STERNBERG, M. D., Major and Surgeon U. S. Army. Prize, | $500 |
| IV. | THE PREVENTABLE CAUSES OF DISEASE, INJURY, AND DEATH IN AMERICAN MANUFACTORIES AND WORKSHOPS, AND THE BEST MEANS AND APPLIANCES FOR PREVENTING AND AVOIDING THEM. By GEORGE H. IRELAND, Springfield, Mass. Prize, | $200 |

That these essays may be placed in the hands of every family in the country is the earnest desire of the association, as well as the heartfelt wish of the public-spirited and philanthropic citizen whose unpretentious generosity and unselfish devotion to the interests of humanity have given us these essays, but the financial inability of the association renders it impossible to distribute them gratuitously;—therefore a price covering the cost has been placed upon these publications. It is to be hoped, however, that government departments, state and local boards of health, sanitary and benevolent associations, etc., will either publish these essays, or purchase editions at cost of the association, for distribution among the people.

Although a copyright has been placed upon these essays for legitimate protection, permission to publish, under certain conditions, can be obtained by addressing the secretary.

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# Disinfection and Individual Prophylaxis agains Infectious Diseases.

## COMMITTEE OF AWARD.

Dr. S. H. Durgin, Health Officer, Boston, Mass.

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# DISINFECTION AND INDIVIDUAL PROPHYLAXIS AGAINST INFECTIOUS DISEASES.

## INTRODUCTION.

*Definition.* We are met at the outset by a difficulty growing out of the fact that the word *disinfection*, as commonly used, has a very different signification from that to which certain recent authors would restrict it. Thus, the Committee on Disinfectants of the American Public Health Association defines a disinfectant as "an agent capable of destroying the infective power of infectious material."[1] In the preliminary report of this committee the reasons for restricting the meaning of the word within the limits justified by its etymology, and of our knowledge of the nature of "infectious material," are very clearly stated, as follows:

"The object of disinfection is to prevent the extension of infectious diseases by destroying the specific infectious material which gives rise to them. This is accomplished by the use of disinfectants.

"There can be no partial disinfection of such material: either its infecting power is destroyed, or it is not. In the latter case there is a failure to disinfect. Nor can there be any disinfection in the absence of infectious material. * * * * * *

"Popularly, the term disinfection is used in a much broader sense. Any chemical agent which destroys or masks bad odors, or which arrests putrefactive decomposition, is spoken of as a disinfectant. And in the absence of any infectious disease it is common to speak of disinfecting a foul cesspool, or a bad-smelling stable, or a privy vault.

"This popular use of the term has led to much misapprehension, and the agents which have been found to destroy bad odors—deodorizers,—or to arrest putrefactive decomposition—antiseptics,—have been confidently recommended and extensively used for the destruction of disease germs in the excreta of patients with cholera, typhoid fever, etc.

"The injurious consequences which are likely to result from such misapprehension and misuse of the word disinfectant will be appreciated when it is known that recent researches have demonstrated that many of the agents which have been found useful as deodorizers, or as antiseptics, are entirely without value for the destruction of disease germs.

"This is true, for example, as regards the sulphate of iron or copperas, a salt which has been extensively used with the idea that it is a valuable disinfectant. As a matter of fact, sulphate of iron in saturated solution does not destroy the vitality of disease germs, or the infecting power of material containing them. This salt is, nevertheless, a very valuable antiseptic, and its low price makes it one of the most available agents for the arrest of putrefactive decomposition in privy vaults, etc.

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[1] *The Medical News*, Phila., Jan. 24, 1885, p. 87.

"Antiseptic agents also exercise a restraining influence upon the development of disease germs, and their use during epidemics is to be recommended when masses of organic material in the vicinity of human habitations cannot be completely destroyed, or removed, or disinfected.

"While an antiseptic agent is not necessarily a disinfectant, all disinfectants are antiseptics; for putrefactive decomposition is due to the development of 'germs' of the same class as that to which disease germs belong, and the agents which destroy the latter also destroy the bacteria of putrefaction, when brought in contact with them in sufficient quantity, or restrain their development when present in smaller amounts.

"A large number of the proprietary 'disinfectants' so called, which are in the market, are simply deodorizers or antiseptics of greater or less value, and are entirely untrustworthy for disinfecting purposes."[1]

The offensive gases given off from decomposing organic material are no doubt injurious to health; and the same is true, even to a greater extent, of the more complex products known as *ptomaines*, which are a product of the vital—physiological—processes attending the growth of the bacteria of putrefaction and allied organisms. It is therefore desirable that these products should be destroyed; and, as a matter of fact, they are neutralized by some of the agents which we recognize as disinfectants, in accordance with the strict definition of the term. But they are also neutralized by other agents—deodorants—which cannot be relied upon for disinfecting purposes, and by disinfectants, properly so called, in amounts inadequate for the accomplishment of disinfection. Their formation may also be prevented by the use of *antiseptics*. From our point of view the destruction of sulphureted hydrogen, of ammonia, or even of the more poisonous ptomaines, in a privy vault, is no more disinfection than is the chemical decomposition of the same substances in a chemist's laboratory. The same is true as regards all of the bad-smelling and little known products of decomposition. None of these are "infectious material," in the sense in which we use these words; that is, they do not, so far as we know, give rise *directly* to any infectious disease. Indirectly they are concerned in the extension of the epidemic "filth diseases," such as cholera and yellow fever, and of the fatal endemic "filth diseases," such as typhoid fever and diphtheria, which in the long run claim more victims than do the pestilential maladies first named. This because persons exposed to the foul emanations from sewers, privy vaults, and other receptacles of filth, have their vital resisting power lowered by the continued respiration of an atmosphere contaminated with these poisonous gases, and are liable to become the victims of any infectious disease to which they may be exposed. Moreover, the accumulations of filth which give off these offensive gases furnish pabulum upon which certain disease germs thrive; and it may happen that the bad smelling air carries something worse than the poisonous gas which makes its presence known by offending the sense of smell. It may waft to our nostrils infectious particles which are beyond recognition by any sense, unless it be the sense of sight with the aid of a good microscope.

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[1] *The Medical News*, April 18, p. 425.

We desire, moreover, to have it fully understood that in restricting the meaning of the term disinfection within the limits given by the definition of the Committee on Disinfectants of the American Public Health Association, we do not wish to limit the practice of "disinfection," in the popular sense of the word.

It is but fair to say, also, that this popular usage is supported by good authority, and until quite recently has been the common acceptation of the term among physicians and chemists. Indeed, it is but a short time since the nose test was the only test of "disinfection" recognized by many intelligent persons.

Littré, in his Dictionary of the French Language, defines disinfectants as "substances which destroy, chemically, bad odors."

Vallin, the author of the best modern treatise upon "Disinfection and Disinfectants," says,—

"From a scientific point of view there is perhaps an impropriety in introducing into the idea of disinfection the suppression of odors which offend the sense of smell. The bad odor is not injurious in itself; it is an epiphenomenon, which does not necessarily give the measure of the hurtful properties of the air, or of any substance whatever. The public, unacquainted with medicine, has an unfortunate tendency to judge of insalubrity by the bad odor: the absence of this gives to it a deceitful security: when they are masked by any device, it [the public] believes that all danger has been removed. *Nevertheless it is necessary to avoid violating the ordinary sense of words.*[1] An atmosphere which does not in the least offend the sense of smell may certainly be insalubrious, and engender the gravest maladies; but the fetid or disagreeable odors may reveal the presence of injurious principles, of toxic gases, or of organic matter in decomposition. We should not too much diminish the importance of these offensive odors in the eyes of the public: everything which smells badly is to be suspected."[2]

We agree with Prof. Vallin, that the bad odors should arouse suspicion, and lead to the use of deodorants, or of antiseptics, or of disinfectants, if required; but let us not leave the public to suppose that when the bad odors have been neutralized, the offensive material has been disinfected. Let us rather instruct the public that to deodorize and to disinfect are not one and the same thing, and that deodorant and disinfectant are not synonymous terms. For our part we prefer to "violate the ordinary sense" of the word, and to restrict its signification within such limits as will prevent confusion, and, what is far worse, a reliance upon inefficient methods for the destruction of infectious material.

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[1] Italics by present writer.

[2] Op. Cit., p. 2.

In the present essay we shall use the words disinfection and disinfectant, in accordance with the definition of the committee on disinfectant already given. But, inasmuch as this is intended to be a practical treatis for popular use, we shall also give, in the proper place, directions for th use of deodorants and of antiseptics, so that "disinfection," in the broa sense in which the word is commonly used, may be fully considered.

*Tests of Disinfection.* What means have we of proving that th infective power of infectious material has been destroyed?

Evidence of disinfection may be obtained (a) from the practical experiments—experience—of those engaged in sanitary work: (b) by inoculation experiments upon susceptible animals; (c) by experiments mad directly upon known disease germs.

(a) It is a matter of common experience, that when a room has been occupied by a patient with an infectious disease, such as small-pox, scarlet fever, or diphtheria, susceptible persons are liable to contract the disease weeks or even months after the patient has been removed from it, unless in the mean time it has been disinfected. If a second case does occur from exposure in such a room, it is evident that it has not been disinfected. But the non-occurrence of subsequent cases cannot always be taken as evidence that the means of disinfection resorted to were efficient. Negative evidence should be received with great caution. In the first place, the question as to whether susceptible individuals have been fairly exposed in the disinfected room must be considered. Then it must be remembered that susceptible persons do not always contract a disease, even when they are exposed in a locality known to be infected. A further difficulty in estimating the value of evidence obtained in practice arises from the fact, that, in connection with the special means of disinfection resorted to, such as fumigation, hanging up cloths saturated with a disinfecting solution, etc., it is customary to resort to additional precautionary measures, such as washing surfaces with soap and hot water, white-washing plastered walls, and free ventilation. It is apparent that under these circumstances it would be unsafe to accept the fact, that no other cases occurred in a room treated in this way, as evidence that the particular disinfectant used is efficient for the destruction of the infectious agent of the disease in question. The fond mother who attaches a charm to her child's neck to protect it from evil, also takes the precaution of guarding it from contact with other children who are sick with any infectious disease. If her child fortunately grows to manhood or womanhood without having suffered an attack of scarlet fever or diphtheria, she may imagine that her charm has protected it, but the evidence upon which her faith is founded is not of a nature to convince those who are familiar with scientific methods of demonstration. "Well educated" persons are often ready to testify in favor of methods of disinfection, or of treatment, upon evidence which, from a scientific point of view, has no more value than that which the fond mother in question has to offer in favor of the little bag containing camphor or assafœtida, or some other charm of equal value, which she has attached to her child's neck to keep it from catching scarlet fever or diphtheria at school. On a par with these charms, so far as disinfection is concerned, we may place the saucer of chloride of lime, which it was formerly the fashion to place under the bed of a patient sick with an infectious disease, the rag saturated with carbolic acid, or chloride of zinc, suspended in the sick-room, and even the fumigations with burning sulphur, as sometimes practised by those who are unfamiliar with the evidence as to the exact value of this agent, and the conditions necessary to ensure successful disinfection with it.

Chloride of lime, sulphurous acid gas. and carbolic acid are among our most useful disinfecting agents, but disease germs are not to be charmed away by them any more than by a little bag of camphor.

Having pointed out the fact that negative evidence, in a restricted field of observation, must be accepted with great caution in estimating the value of disinfectants, we hasten to say that the combined experience of sanitarians, derived from practical efforts to restrict the extension of infectious diseases, is of the greatest value, and that this experience is to a great extent in accord with the results of exact experiments made in the laboratory.

(b) Inoculation experiments upon susceptible animals, made directly with infectious material which has been subjected to the action of a disinfectant, have been made by numerous observers. The proof of disinfection in this case is failure to produce the characteristic symptoms which result from inoculation with similar material not disinfected. Thus, Davaine found that the blood of an animal just dead from the disease known by English writers as anthrax or splenic fever (Fr. *Charbon*), inoculated into a healthy rabbit or Guinea-pig, in the smallest quantity, infallibly produces death within two or three days; and the blood of these animals will again infect and cause the death of others, and so on indefinitely. This anthrax blood therefore was infectious material, which could be utilized for experiments relating to the comparative value of disinfectants. Davaine made many such experiments, not only with the blood of anthrax, but also with that of a fatal form of septicæmia in rabbits, which is known by his name. Other investigators have followed up these experiments upon infectious material of the same kind, and also upon material from other sources—*e. g.*, the infectious material of glanders, of tuberculosis, of symptomatic anthrax, of fowl cholera, of swine plague, etc.

It has been proved that the infectious agent in all of the diseases mentioned is a living germ, and that disinfection consists in destroying the vitality of this germ. But in experiments made with blood or other material obtained directly from diseased animals, the results would be just as definite and satisfactory if we were still ignorant as to the exact nature of the infecting agent. The test shows the destruction of infecting power without any reference to the cause of the special virulence, which is demonstrated to be neutralized by certain chemical agents in a given amount. All of the experiments made with the above mentioned kinds of virus have been made upon the lower animals; but there is one kind of material which it is justifiable to use upon man himself, and with which numerous experiments of a very satisfactory character have been made. This material is vaccine virus. Fresh vaccine, when inoculated into the arm of an unvaccinated person, gives rise to a very characteristic result,—the vaccine vescicle. The inference seems justified that any agent which will neutralize the specific infecting power of this material will also neutralize the small-pox virus. Thus far it has not been definitely proved that the infective agent in vaccine virus is a living germ; but the numerous experiments made have shown that the chemical agents, which have the power of destroying the various kinds of infectious material heretofore mentioned, have also the power, in about the same amounts, of neutralizing vaccine virus, as shown by its failure to produce any result when inoculated into an unvaccinated person. In these experiments the more careful investigators have taken the precaution of vaccinating the same person with disinfected and with non-disinfected virus from the same source. A successful vaccination with the non-disinfected virus shows that the individual is susceptible, and the material good: failure to produce any result is evidence that the potency of the disinfected virus has been destroyed by the chemical agent to which it was exposed.

(c) As already stated, it has been demonstrated that the infectious diseases of the lower animals, which have furnished the material for experiments upon disinfectants by the method of inoculation, are "germ diseases," and that the infectious agent is in each case a living micro-organism, belonging to the class known under the general name of *Bacteria*. The bacteria are vegetable organisms, which, by reason of their minute size and simple organization, must be placed at the very foot of the scale of living things. But they make up in number and in rapidity of development for their minute size; and there is good reason for believing that the infectious diseases of man are also caused by pathogenic—disease-producing—organisms of the same class. Indeed, this has already been proved for some of these diseases, and the evidence as regards several others is so convincing as to leave very little room for doubt.

Many of these disease germs are now known to us, not only by microscopic examination of the blood and tissues of infected animals, but also by "culture experiments." That is, we are able to cultivate them artificially in suitable media, and to study their mode of development, etc., in the laboratory, quite independently of the animals from which our "pure cultures" were obtained in the first instance. The culture fluids used are prepared from the flesh of various animals; and when to one of these a certain quantity of gelatine is added, we have a "solid culture medium," upon the surface of which some of these germs will grow most luxuriantly. To start such a "culture," it is only necessary to transfer, with proper precautions, a minute quantity of the infectious material to the surface of our culture medium, or into a fluid which has been found to be suitable for the growth of the particular organism which we desire to cultivate. A second culture is in the same way started from the first, and so on indefinitely.

Now it is evident that these "pure cultures" furnish us a ready means for testing the power of various chemical agents to destroy the vitality of known disease germs, as shown by their failure to grow in a suitable culture medium after exposure for a given time to a given percentage of the disinfectant. Very many experiments of this nature have been made during the past three or four years. The reader who desires fuller details as to the method of conducting such experiments, and of the results obtained, is referred to the preliminary reports of the committee on disinfectants, of the American Public Health Association, published during the current year (1885) in the *Medical News*, Philadelphia, and which will, doubtless, also be published in full in the next annual volume of the association. We may say here, that the experimental data on record indicate that those agents which are efficient for the destruction of any one of the pathogenic organisms upon which experiments have been made, or of harmless species of the same class,—*e. g.*, the bacteria of putrefaction,—are efficient for the destruction of all, ***in the absence of spores***. There is, it is true, within certain limits, a difference in the resisting power of different organisms of this class to chemical agents. This is not, however, sufficiently marked to prevent the general statement that ***a disinfectant for one is a disinfectant for all, in the absence of spores.***

The last clause of the above statement calls for an explanation, and certain details with reference to the mode of reproduction of disease germs. All of the bacteria multiply by binary division; that is, one individual divides into two, and each member of the pair again into two, and so on. The spherical bacteria, known as ***micrococci***, multiply only in this way, but the rod-shaped bacteria, or ***bacilli***, also form spores. These spores correspond with the seeds of higher plants. They are highly refractive, oval or spherical bodies, which, under certain circumstances, make their appearance in the interior of the rods, which cease to multiply by binary division when spore formation has taken place. The point of special interest with reference to these spores is, that they have a resisting power to heat, and to the action of chemical disinfectants, far beyond that which is possessed by micrococci, or by bacilli without spores. The difference may be compared to the difference between a tender plant and its seeds to deleterious influences, such as extremes of heat and cold. Thus the spores of certain species of bacilli withstand a boiling temperature for several hours, while a temperature of 150° Fahr. quickly kills most bacteria in the absence of spores. A similar difference is shown as regards the action of chemical agents. Certain agents,—*e. g.*, sulphurous acid gas and carbolic acid,—which are extensively used as disinfectants, have been proved by exact experiments to be quite impotent for the destruction of spores. This being the case, it is advisable, in practical disinfection, always to use an agent which has the power of destroying spores, in those cases in which the exact nature of the disease germ has not been demonstrated. The cholera germ of Koch does not form spores; and there is good reason to believe that the same is true as regards the germs of yellow fever, of scarlet fever, and of small-pox, which have not yet been demonstrated. This inference is based upon evidence obtained in the practical use of disinfectants, and upon certain facts relating to the propagation of these diseases.

A second general statement, which is justified by the experimental evidence on record, is, that *agents which kill bacteria in a certain amount, prevent their multiplication in culture fluids, when present in quantities considerably less than are required to completely destroy vitality*

An agent, therefore, which, in a certain proportion and in a given time, acts as a "germicide" in a smaller quantity, may act as an *antiseptic, i. e.*, may prevent putrefactive decomposition by restraining the development of the bacteria of putrefaction. Antiseptics also prevent or retard the development of pathogenic bacteria. It follows from this that germicides are also antiseptics; but the reverse of this proposition is not true as a general statement, for all antiseptics are not germicides. Thus alcohol, common salt, sulphate of iron, and many other substances which are extensively used as antiseptics, have scarcely any germicide power, even in concentrated solutions, and consequently would be entirely unreliable as disinfectants.

Practically, antiseptics may accomplish the same result in the long run as we obtain in a short time by the use of disinfectants. If, for example, we prevent the development of the germs of cholera, or of typhoid fever, in an infected privy vault, by the continued use of antiseptics, these germs will in time lose their ability to grow, when introduced into a suitable culture medium. But in the meantime there is always the possibility that some of them may escape, with the fluid contents of the vault, into the surrounding soil, and contaminate some well or stream from which drinking-water is obtained. For this reason privy vaults, cesspools, and sewers should never be allowed to become infected. All infectious material, such as the dejections of patients with cholera or typhoid fever, should be destroyed at its source, in the sick-room; or, if it is ascertained that such material has been thrown into a privy vault, the entire contents of the vault should be promptly disinfected. The same rule applies to infectious material thrown upon the ground, or wherever it may be.

Finally, we desire to emphasize the following propositions:

*Disinfection* consists in extinguishing the spark, killing the germ, which may light up an epidemic in the presence of a supply of combustible material—filth.

The object of *general sanitary police* is to remove this combustible material out of the way, so that no harm may result even if the spark be introduced.

*Antiseptics and deodorants* are useful when it is impracticable to remove offensive organic material from the vicinity of human habitations, but they are a poor substitute for cleanliness.

# PART FIRST.

## DISINFECTION.

It will be our aim in the present chapter to give reliable, practical directions with reference to the use of disinfectants, and the best methods of disinfection. Keeping this object in view, we shall recommend for disinfecting purposes only those agents named in the following list:

### *Group 1.*

Disinfectants which have the power of destroying spores:

1. Fire.
2. Steam under pressure (25 lbs.).
3. Boiling water.
4. Chloride of lime (in solution).
5. Liquor sodæ chlorinatæ.
6. Mercuric chloride (in solution).

### *Group 2.*

Disinfectants which are effective in the absence of spores:

7. Dry heat (230° Fahr. for two hours).
8. Sulphur dioxide.
9. Carbolic acid.
10. Sulphate of copper (in solution)
11. Chloride of zinc (in solution).

NOTE. In the present state of knowledge, a division of disinfecting agents into two groups becomes necessary, unless we would entirely dispense with the use of those agents named in our second group, which cannot be relied upon for the destruction of spores, and consequently cannot be recommended for the destruction of all kinds of infectious material. As this group includes several agents which are extensively used for disinfecting purposes, and which we believe to possess great practical value, we have considered it necessary to make this distinction. The present state of science, however, does not enable us to classify all infectious diseases in the same way, and in case of doubt it will always be advisable to use those agents included in Group 1. But in the absence of a precise knowledge of the nature of the germ, we may in certain cases be governed by the practical experience of sanitarians, and by experiments which have been made directly upon infectious material, *e. g.*, on vaccine virus. In our recommendations we have taken account of this kind of evidence, as well as of laboratory experiments, in which known disease germs or harmless organisms of the same class have served as the test of disinfecting power.

We shall first give a brief account of the conditions of successful disinfection with these agents, as established by experimental data, and afterward detailed directions for their employment under the various circumstances in which disinfection is required.

*1. Fire.* It is hardly necessary to say that burning of infectious material, infected clothing, etc., is an effectual method of disposing of it. This method of disinfection is always to be recommended, when practicable or consistent with a due regard for economy and the rights of individuals. As a rule, articles of little value, which have been soiled with infectious material, had better be burned; and this is especially true of old clothing and bedding. But we have other efficient methods of disinfection, which make it unnecessary to sacrifice articles of value except under unusual circumstances.

*2. Steam under Pressure.* The disinfecting power of steam given off from boiling water in an open vessel does not differ from that of the water itself, but confined steam has a temperature corresponding with the pressure as indicated by a steam gauge. At twenty pounds pressure the temperature is about 230° Fahr. (105° C.) ; at twenty-five pounds it is about 240° Fahr. ; at thirty pounds it is 250° Fahr. Moist heat at the lowest temperature named destroys the most resistant spores in twenty minutes, while a temperature of 240° Fahr. is effective almost immediately.[1]

*3. Boiling.* In the absence of spores, bacteria are quickly killed at a temperature considerably below the boiling point of water, and it is safe to say that boiling for half an hour will destroy all known disease germs, including the spores of anthrax, which have less resisting power than the spores of certain harmless and widely distributed bacilli, which have been found to resist boiling for several hours.

*4. Chloride of Lime* (chlorinated lime, bleaching powder). This is one of the cheapest and most efficient of disinfectants. It should be packed in air-tight and moisture-proof receptacles,—glass is preferable,—and should contain at least 25 per cent. of available chlorine.[2] It should be used in solution, which had better be made as required. An insoluble residue will be left, which may be removed by filtration or decantation. This, however, is not at all necessary. Chlorinated lime owes its disinfecting power to the presence of the hypo-chlorite of lime, a salt which is freely soluble in water, and which is quickly decomposed by contact with organic matter. Germs of all kinds, including the most resistant spores, are destroyed by this solution, but it must be remembered that the disinfectant itself is quickly decomposed and destroyed by contact with organic matter, and that if this is present in excess, disinfection may not be accomplished, especially when the germs are embedded in masses of material which are left after the hypo-chlorite of lime has all been exhausted in the solution.

*5. Liquor Sodæ Chlorinatæ* (Labarraque's solution). This is a solution of the hypo chlorite of soda. Its value as a disinfectant corresponds with that of solutions of the hypo-chlorite of lime of the same strength. The preparations in the market vary greatly in value, and some of those tested by the committee on disinfectants[3] were found to be practically without value. This is due to the fact that the solution does not keep well. For this reason, and on the score of economy, a solution of chloride of lime will be preferable for most purposes. Labarraque's solution is, however, a more pleasant preparation for bathing the surface of the body, and both as a deodorant and a disinfectant will be found useful in the sick-room. It should contain at least 3 per cent. of available chlorine.

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[1] See Preliminary Report of Committee on Disinfectants, in *The Medical News*, Philadelphia, March 14, 1885, p. 284.

[2] The test for available chlorine is given in Preliminary Report No. 11 of the Committee on Disinfectants, l. c., Jan. 7, p. 148.

[3] l. c., p. 659.

*6. Mercuric Chloride* (bichloride of mercury, corrosive sublimate). This salt is well known as a deadly poison, which has long been used in domestic practice as a "bug poison." Recent researches show that it has germicide powers of the first order, and it is consequently a disinfectant which may be recommended for certain purposes, due regard being had to its poisonous nature, and to the fact that it is decomposed by contact with lead, tin, or copper, and that lead pipes are soon rendered brittle and worthless by passing through them solutions of mercuric chloride. Its potency in dilute solutions (1 : 500 to 1 : 4000) makes it comparatively cheap,[1] and the danger of accidental poisoning from such dilute solutions is not very great. The concentrated solutions should be colored, as a precaution against accident, for they have neither color nor odor to reveal their deadly nature.

A standard solution which contains four ounces to the gallon of water is of convenient strength for a concentrated solution, to be issued by manufacturers or health authorities, in properly labelled bottles. This may be colored with permanganate of potash,[2] or with indigo, or with aniline blue. Inasmuch as standard solution No. 2 of the committee on disinfectants is colored with the permanganate, it would perhaps be better to give this solution a blue color. The writer would suggest the following formula, in which another poisonous metallic salt contained in our list is combined with the mercuric chloride:

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|---|---|
| Bichloride of mercury, . . . . . . . . . . . . | 4 ounces. |
| Sulphate of copper, . . . . . . . . . . . . . | 1 pound. |
| Water, . . . . . . . . . . . . . . . . . . | 1 gallon. |

It must be remembered, in using this and other disinfecting solutions, that the condition relating to time of exposure to the action of the disinfecting agent is an important one. The experimental evidence[3] relating to the germicide power of mercuric chloride shows that the time of exposure being two hours, this salt may be safely recommended for the destruction of spore-containing infectious material in the proportion of 1 : 1000, and of pathogenic organisms in the absence of spores in the proportion of 1 : 4000, or even less, *provided that the micro-organisms to be destroyed are fairly exposed to its action.* The fact that mercuric chloride combines with and coagulates albuminous material, interferes to some extent with its value as a disinfectant, and will be kept in view in the recommendations to be made hereafter relating to the practical use of this agent. Mercuric chloride is an efficient antiseptic in the proportion of 1 : 15,000, and it exercises a restraining influence upon the development of the spores of the anthrax bacillus, when present in culture solutions, in the proportion of 1 : 300,000, and even less.

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[1] It costs about fifty cents a pound by the quantity.

[2] Ten grains to the gallon is sufficient.

[3] *The Medical News,* Feb. 21, p. 205.

*7. Dry Heat.* Dry heat is only to be recommended for the disinfection of such articles as would be injured by exposure to moist heat, or to a disinfecting solution. A properly constructed disinfection chamber or "oven" is absolutely essential, if dry heat is to be used. The experimental evidence on record[1] shows that the destruction of spores requires a temperature which would injure woollen fabrics (140° C. for three hours). In the absence of spores, however, articles which are freely exposed for two hours to a temperature of 110° C. (230° Fahr.) may with safety be considered disinfected. In practice it will be necessary to remember that the penetrating power of dry heat is very slight, and that packages, bundles, or even articles loosely thrown one upon another, cannot be disinfected in this way.

*8. Sulphur Dioxide* (sulphurous acid gas). Fumigation with burning sulphur has long been a favorite method of disinfection. The experience of sanitarians is in favor of its use in yellow fever, small-pox, scarlet fever, diphtheria, and other diseases in which there is reason to believe that the infectious material does not contain spores. The experimental evidence on record[2] shows that under certain conditions it is effective for the destruction of micro-organisms in the absence of spores, but that it is quite impotent for the destruction of these reproductive elements.

The presence of moisture adds greatly to the disinfecting power of this agent. It is freely soluble in water, one volume dissolving fifty volumes of the gas. It is therefore evident that a saturated aqueous solution is fifty times as strong as the pure gas—anhydrous. In aqueous solution, in the proportion of 1 : 2000 by weight, sulphur dioxide kills micrococci in two hours' time.[3] In a gas-tight receptacle it destroys the infecting power of vaccine virus dried upon ivory points, when present in the proportion of one volume per cent., the time of exposure being six hours.[4] The same proportion destroys anthrax bacilli, without spores, from the spleen of an animal recently dead, dried upon silk threads, in thirty minutes (Koch). These facts show that sulphur dioxide is a valuable disinfectant; but the conditions of successful disinfection, as established by the experimental evidence, are, that the material to be disinfected shall be freely exposed to its action for a considerable time, *in a receptacle which does not permit the gas to escape.* It must be remembered that disinfection of a thin layer of vaccine virus upon an ivory point, or of anthrax blood upon a silk thread, exposed in a gas-tight receptacle, cannot be taken as evidence that thicker layers of infectious material, attached to the surface of bedding and clothing, or enclosed in folded blankets, bundles of clothing, matresses, etc., can be disinfected by the same amount of sulphur dioxide generated in a room which is not gas-tight. It has been shown, by carefully conducted experiments,[5] that the escape of sulphurous acid gas from a bed-chamber or hospital ward is very rapid, in spite of the usual precautions for stopping up crevices when such a room is to be fumigated; and infectious material, enclosed in bundles or protected by folds of blankets, etc., may escape disinfection, after having been exposed for many hours in a tightly closed chamber containing ten volumes per cent. of this gas.

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[1] See *Medical News*, March 14, p. 283.

[2] See Prelim. Rep., No. VII, *The Med. News*, March 28, p. 345.

[3] l. c., p. 348.

[4] l. c., p. 344.

[5] l. c., p. 348.

*9. Carbolic Acid.* The disinfecting power of carbolic acid has been fixed by experiments upon vaccine virus, and upon various pathogenic organisms. A saturated aqueous solution cannot, however, be relied upon for the destruction of spores; but in the absence of spores it is fatal to micro-organisms in the proportion of two per cent., the time of exposure being two hours. Indeed, less than one per cent. is fatal to several of the species of pathogenic micrococci which have served as test-organisms in the numerous experiments which have been made with this agent.[1] Upon the recommendation of the famous Dr. Koch, the discoverer of the cholera bacillus, the committee on disinfectants, of the International Sanitary Conference of Rome (1885), has given this agent the first place for disinfecting soiled clothing, excreta, etc., in cholera. For excreta it is to be used in five per cent. solution, and for clothing, etc., in two per cent. solution. The experimental evidence upon record indicates that it may be relied upon in this proportion.

*10. Sulphate of Copper.* This salt has been largely used as a disinfectant in France, and recent experiments show that in the proportion of one per cent. it is a reliable agent for the destruction of micro-organisms, in the absence of spores. It is much below mercuric chloride in germicide power, but is a better deodorant—not a better antiseptic—than the more poisonous salt. When we take into account its efficiency, it is comparatively cheap, and is to be recommended for certain purposes. It may be combined with the more potent germicide, mercuric chloride, in accordance with the formula already given.

*11. Chloride of Zinc.* Solutions of chloride of zinc are largely used in this country and in Europe for disinfecting purposes. It is an excellent antiseptic and deodorant, but its power to destroy disease germs has been very much over-estimated. It may, however, be relied upon for the destruction of pathogenic organisms, in the absence of spores, in solutions which contain from five to ten per cent. of the salt.

## GENERAL DIRECTIONS FOR DISINFECTION.

"In the sick-room we have disease germs at an advantage, for we know where to find them, as well as how to kill them. Having this knowledge, not to apply it would be criminal negligence, for our efforts to restrict the extension of infectious diseases must depend largely upon the proper use of disinfectants in the sick-room."[2]

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[1] Prelim. Rep. of Com. on Disinfectants, No. VI, l. c., p. 317.

[2] Prelim. Rep. of Com. on Disinfectants of A. P. H. A.

*Disinfection of Excreta, etc.* The dejections of patients suffering from an infectious disease should be disinfected before they are thrown into a water-closet or privy vault. This is especially important in cholera, typhoid fever, yellow fever, and other diseases in which there is evidence that the infectious agent is capable of self-multiplication, in suitable pabulum, external to the human body. Vomited matters, and the sputa of patients, with these and other infectious diseases, should also be promptly disinfected. This is especially important in cholera, diphtheria, scarlet fever, whooping-cough, and tuberculosis. It seems advisable, also, to treat the urine of patients sick with an infectious disease with a disinfecting solution.

For the disinfection of excreta, etc., in the sick-room, a solution of chloride of lime is to be recommended. This is an excellent and prompt deodorant, as well as a disinfectant. A quart of the standard solution (No. 1), recommended by the committee on disinfectants, of the American Public Health Association, will suffice for an ordinary liquid discharge in cholera or typhoid fever; but for a copious discharge it will be prudent to use twice this quantity, and for solid fecal matter a stronger solution will be required. As chloride of lime is quite cheap, it will be best to keep on the safe side, and to make the solution for the disinfection of excreta by dissolving eight ounces of chloride of lime in a gallon of water. This solution should be placed in the vessel before it receives the discharge. The material to be disinfected should be well mixed with the disinfecting solution by agitating the vessel, and from thirty minutes to an hour should be allowed for the action of the disinfectant, before the contents are thrown into a water-closet or privy vault

*Standard Solution No. 2*, of the committee on disinfectants, which contains two drachms of corrosive sublimate and two drachms of permanganate of potash to the gallon of water, if used freely—one quart for each dejection—and left in contact with the material to be disinfected for at least four hours, is a reliable disinfectant *for liquid discharges*. The caution with reference to lead pipes must be remembered, and if this solution is used in the sick-room or in hospital wards, it will be desirable to have receptacles of wood or earthern ware for the disinfected material, which may be carried away and emptied in a suitable locality once in twenty-four hours.

The blue solution heretofore suggested would also be suitable for use in the same way, and with the same precautions. It contains four ounces of corrosive sublimate and a pound of sulphate of copper to the gallon of water. This concentrated solution should be diluted in the proportion of eight ounces to the gallon of water, and the diluted solution used as heretofore recommended—at least a quart for each dejection, and four hours' time. The disinfecting power of the copper salt adds to the value of this solution, and the bright blue color of the concentrated solution leaves nothing to be desired in the way of a color protection against accidental poisoning.

For the disinfection of the discharges of cholera patients, a five per cent. solution of carbolic acid may be used, in accordance with the recommendation of the International Sanitary Conference of Rome. The time necessary to insure disinfection is fixed at four hours.

Chloride of zinc in ten per cent. solution may be used for the dejections of cholera patients, the same conditions being observed in regard to quantity and time of exposure as were fixed for the other metallic salts named.

It will be best to burn cloths used to wipe away the discharges of the sick, and especially those used in wiping away the infectious material from the mouth and nostrils of patients with diphtheria or scarlet fever. Bits of old muslin may be used for this purpose, and should at once be thrown upon an open fire or gas stove arranged in the fire-place for this purpose.

Infected sputum may be discharged directly into a cup half full of the solution of chloride of lime recommended for excreta, or of Labarraque's solution.

Handkerchiefs, napkins, and towels used in wiping away infectious discharges, if worth preserving, should be at once immersed in one of the following solutions: Chloride of lime, 2 per cent.; carbolic acid, 2 per cent.; mercuric chloride, 0.1 per cent. (=1 : 1000).

The blue solution (containing sulphate of copper), diluted in the proportion of four ounces to the gallon of water, may also be used for this purpose. Cloths used for washing the general surface of the body should also be disinfected with one of the above mentioned solutions; and attendants should invariably disinfect their hands by washing them in one of these solutions, when they have been soiled by the discharges of the sick.

*Disinfection of the Person.* Labarraque's solution, diluted with twenty parts of water, is a suitable disinfecting solution for bathing the entire surface of the body of the sick, of convalescents, or of those whose duties take them into the sick-room; or a 1 per cent. solution of chloride of lime, or a 2 per cent. solution of carbolic acid, may be used.

The International Sanitary Conference of Rome gives the following directions with reference to the disinfection of the body after death from cholera:

"The body should be enveloped in a sheet saturated with one of the strong disinfecting solutions,[1] without previous washing, and should at once be placed in a coffin."

We see no objection to washing the body, if the strong solution of chloride of lime is used for this purpose. Washing with water would necessitate the careful disinfection of the water and cloths used for this purpose, and of the hands of the attendants. As the odor of chlorine or of carbolic acid would be objectionable under certain circumstances, we see no good reason for insisting upon the use of these agents, rather than on the odorless solution of mercuric chloride, which, in the proportion of 1 : 1000, would no doubt be equally effective. But when there is an odor of decomposition to be neutralized, the solution of chloride of lime will have a decided advantage on account of its deodorizing properties.

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[1] Chloride of lime 4 per cent., or carbolic acid 5 per cent.

*Disinfection of Clothing and Bedding.* The cheapest and best way of disinfecting clothing and bedding, which is not injured by the ordinary operations of the laundry, is to immerse it in boiling water for half an hour or longer. It should be placed in boiling water as soon as removed from the person or the bed of the sick, and if it is necessary to remove the articles from the room in order to accomplish this, they should be wrapped in a sheet or towel thoroughly saturated with a disinfecting solution. If it is impracticable to disinfect such infected clothing and bedding *immediately* by boiling, it will be necessary to immerse it in one of the following disinfecting solutions, in which it should be left for four hours: Mercuric chloride, 1 : 2000; or the "blue solution" of this salt and sulphate of copper, diluted by adding two fluid ounces of the concentrated solution to a gallon of water; or a 2 per cent. solution of carbolic acid. The solution of chlorinated lime (2 per cent.) may also be used, but we give the precedence to the first mentioned solutions, because of the bleaching properties of this solution. The blue solution does not injure clothing, and is to be preferred for domestic use to a simple solution of corrosive sublimate, which in the concentrated form is highly poisonous, and without odor or color. When diluted as directed, this solution may, however, be used without danger either from absorption through the hands, or by drinking. The metallic taste of the diluted solution could scarcely fail to prevent a fatal dose from being swallowed accidentally.

For outer clothing, and other articles which would be seriously injured by immersion in boiling water, the best disinfectant is *steam*. Exposure to steam at 100° C. (212° Fahr.) for half an hour would be equivalent to exposure in boiling water for the same time, if the clothing is hung up in such a manner as to be fairly brought under the action of the disinfecting agent. To be certain that the steam does not fall below this temperature in the disinfection chamber, a thermometer must be placed in a corner of the room, at a distance from the point of entrance of the steam, or in an aperture from which the steam escapes. This should mark at least 100° C. for half an hour before the disinfection can be considered complete.[1] To accomplish this, it is evident that the steam must come from the generator at a higher temperature, or, in other words, must be under pressure.

It must be remembered that the destruction of spores is the most difficult test of disinfecting power known, and one which excludes the use of carbolic acid, sulphur dioxide, and other agents which enjoy the confidence of sanitarians, and which have been proved by laboratory experiments to destroy pathogenic organisms in the absence of spores. There is good reason for the belief that *dry heat* and *sulphurous acid gas* may be safely substituted for steam for the disinfection of the clothing of patients with cholera, yellow fever, and small-pox, and probably in several other infectious diseases (puerperal fever, erysipelas, diphtheria (?), and scarlet fever (?).

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[1] The committee on disinfectants of the International Sanitary Conference of Rome fixes one hour as the time during which steam should be made to pass over the articles to be disinfected.

As disinfection by steam will injure certain articles, *dry heat* may be used as a substitute for moist heat, but in this case a temperature of at least 110° C. (230° Fahr.), maintained for two hours, will be required. In the use of dry heat, even greater care is necessary that the articles to be disinfected are freely exposed,—that is, not placed in the oven in bundles, or piled one upon another, but freely suspended in the disinfecting chamber. For it has been shown by carefully conducted experiments that the penetrating power of dry heat is very slight. A properly constructed disinfection oven, such as that of Ransom,[1] will be required if dry heat is to be used.

As the appliances for disinfecting with steam or with dry heat are somewhat expensive, these agents are not likely to supplant, for general use, the time-honored practice of fumigation with sulphurous acid gas. This method of disinfection commends itself because of the cheapness of the material used, and the facility of its application. Sulphur dioxide is a less reliable disinfectant than steam or dry heat, but when the necessary conditions are observed there is no doubt of its utility; and the fact that it does not kill the spores of anthrax and of other bacilli is no reason for rejecting an agent which has been demonstrated by experience to be one of great value, which has been proved by laboratory experiments to be fatal to pathogenic organisms in the absence of spores, and to destroy the infecting power of vaccine virus. But in using this agent the conditions of successful disinfection, which have been established by experiment, should be borne in mind. The room which is to serve as a disinfecting chamber must be very thoroughly closed: every crevice and key-hole should be carefully stopped with cotton, or by fastening paper over it. Even this precaution will not prevent the rapid escape of gas from cracks around doors, windows, etc. It is therefore desirable, when practicable, to use a disinfecting chamber which can be hermetically closed. The articles to be disinfected must be very freely exposed, and should never be thrown into the room in bundles, or piled one upon another. We concur in the recommendations of the committee on disinfectants of the American Public Health Association, as to the amount of sulphur which should be burned, and the method of effecting its complete combustion:

> "To secure any result of value, it will be necessary to close the apartment to be disinfected as completely as possible, by stopping all apertures through which gas might escape, and to burn at least three pounds of sulphur for each thousand cubic feet of air-space in the room. To secure complete combustion of the sulphur, it should be placed, in powder or in small fragments, in a shallow iron pan, which should be set upon a couple of bricks in a tub partly filled with water, to guard against fire. The sulphur should be thoroughly moistened with alcohol before igniting it."[2]

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[1] *British Medical Journal*, Sept. 6, 1873, p. 274.

[2] Preliminary Report, l. c., p. 427.

Finally, we would remark, that in the absence of suitable appliances for disinfection, and in general when the infected articles are of little value, consumption by fire furnishes the readiest and safest method of disposing of such articles.

For articles of value, such as upholstered furniture, etc., which would be injured by any of the processes heretofore recommended, free exposure to the air (aeration) for three or four weeks is directed by the committee on disinfectants of the International Sanitary Conference of Rome. The same committee directs that "objects made of leather, such as trunks, boots, etc., should be destroyed, or washed several times with one of the weak disinfection solutions,"—carbolic acid 2 per cent., or chloride of lime 1 per cent.

The means heretofore recommended for the disinfection of woollen clothing, blankets, and similar articles will not be sufficient for soiled mattresses. As a rule, they should be opened, and the contents disinfected by steam or by dry heat, with subsequent free aeration, and the cover should be washed in boiling water after treatment with a disinfecting solution.

*Disinfection of the Sick-Room.* Every effort should be made to prevent a room occupied by patients sick with an infectious disease from becoming infected. Carpets, stuffed furniture, curtains, and other articles difficult to disinfect, should be removed at the outset. Indeed, nothing should be left in the room which is not absolutely required, and all furniture and utensils should be of such a character that they can be readily disinfected by washing with boiling water or with a disinfecting solution. Abundant ventilation and scrupulous cleanliness should be maintained, and a disinfecting solution should always be at hand for washing the floor, or articles in use, the moment they are soiled by infectious discharges. For this purpose a solution of chloride of lime may be used (4 per cent.).

It is impracticable to destroy infectious material in an *occupied* apartment by means of gases or volatile disinfectants, for to be effective these must be used in a degree of concentration which would make the atmosphere of a room quite irrespirable. These agents are therefore useful only as deodorants. They are all more or less offensive to the sick, and will seldom be required, even as deodorants, when proper attention is paid to cleanliness and ventilation.

Daily wiping of all surfaces—floors, walls, and furniture—with a cloth wet with a disinfecting solution, is to be recommended. For this purpose a solution of chloride of lime (2 per cent.), or of carbolic acid (2 per cent.), or of mercuric chloride (1 : 2000), may be used.

By such precautions as have been indicated, the infection of the sick-room may be prevented, especially in those diseases, such as cholera and typhoid fever, in which the infectious agent is not given off in the breath, or from the general surface of the body, of the sick person. In small-pox and in scarlet fever there is greater danger that the infectious agent may remain attached to surfaces in the room; for the atmosphere becomes infected with particles given off from the surface of the patient's body.

As already stated, the atmosphere cannot be disinfected while the room is occupied. There is much less reason for disinfecting it when the patient has been removed, and it is much simpler to renew it by throwing open the doors and windows than to attempt to disinfect it. Indeed, there will be no infectious particles to destroy, except such as are dislodged from surfaces, window ledges, etc., where they have settled as dust while the room was occupied; and if the precautions above recommended have been taken, the danger of such reinfection of the atmosphere will be reduced to a minimum.

Disinfection of the vacated room, then, consists in the destruction of all infectious particles which remain attached to surfaces, or lodged in crevices, in interstices of textile fabrics, etc. The object in view may be accomplished by thorough washing with one of the disinfecting solutions heretofore recommended; but most sanitarians think it advisable, first, to fumigate the room with sulphur dioxide. This practice is to be recommended, and the directions given by the committee on disinfectants, already quoted, should be followed (3 lbs. of sulphur to 1,000 cubic feet of air space). At the end of from twelve to twenty-four hours, doors and windows should be opened, and the room freely ventilated. After this fumigation, all surfaces should be washed with a disinfecting solution (chloride of lime 2 per cent., carbolic acid 2 per cent., or mercuric chloride 1 : 1000), and afterwards thoroughly scrubbed with soap and hot water. Plastered walls should be white-washed. The fumigation recommended is especially important in the case of rooms, the walls of which are covered with paper, and in rooms from which curtains, carpets, etc., have not been removed; and under these circumstances it will, as a rule, be advisable to repeat the fumigation a second or even a third time. The process is inexpensive, and the old saying that "Whatever is worth doing at all is worth doing well," applies with especial force to the use of disinfectants. Excessive precaution can do no harm, but the inefficient use of disinfecting agents, which results from indifference, or from ignorance of the precise value of the agents relied upon, may be disastrous.

*Disinfection of Privy Vaults, Cesspools, etc.* The contents of privy vaults and cesspools should never be allowed to accumulate unduly, or to become offensive. By frequent removal, and by the liberal use of antiseptics, such necessary receptacles of filth should be kept in a sanitary condition. The absorbent deodorants, such as dry earth, or pounded charcoal,—or the chemical deodorants and antiseptics, such as chloride of zinc, sulphate of iron, etc.,—will, under ordinary circumstances, prevent such places from becoming offensive. Disinfection will only be required when it is known, or suspected, that infectious material, such as the dejections of patients with cholera, yellow fever, or typhoid fever, has been thrown into the receptacles, which are especially dangerous, because they already contain pabulum suitable for the development of the germs of these diseases. Mercuric chloride commends itself especially for the disinfection of such masses of material, because, even if any germs escape immediate destruction, they will fail to multiply in the presence of this potent antiseptic. The chloride of lime solution, on the contrary, is preferable for use in the sick-room, because of the promptness and certainty of its germicide action and its deodorizing power. But it has the disadvantage, where large masses of material are to be disinfected, that it is itself destroyed by contact with organic matter; and that if there is a surplus of infectious material after the disinfecting solution has been neutralized, this will be as potent for mischief as a larger quantity would have been.

Mercuric chloride should be used *in solution*, in the proportion of "one pound for every five hundred pounds—estimated—of fecal matter contained in the vault.[1] All exposed portions of the vault, and the wood-work above it, should be thoroughly washed down with the disinfecting solution."[2]

The subsequent daily use of a smaller quantity of the same solution would ensure the continued disinfection of fresh material thrown into the vault. Or chloride of lime in powder may be freely scattered over the contents after the first disinfection with mercuric chloride. A diluted powder, made by mixing one pound of chloride of lime with nine pounds of plaster of Paris, or of clean, well dried sand, may be used for this purpose. This is more easily spread about, can be used more economically, and is sufficiently strong in chlorine for practical purposes. As chloride of lime is an excellent deodorant as well as a disinfectant, such a powder commends itself for general use in open privy vaults and cesspools, not only during the prevalence of epidemics, but at all times when they give evidence of being in an unsanitary condition.

*Hospitals.* The directions already given in regard to disinfection of the sick-room and its contents apply as well to hospital wards in which patients with infectious diseases are treated. In addition to this, it will be necessary in hospitals to guard against such infectious diseases as erysipelas, septicæmia, puerperal fever, and hospital gangrene. The antiseptic treatment of wounds, in connection with a proper regard for cleanliness and ventilation, has practically banished these diseases from well regulated hospitals. Of the first importance in effecting this are the precautions now taken with reference to the disinfection of sponges, instruments, the hands of attendants, etc.

Instruments of silver, such as probes and catheters, may be disinfected by passing them through the flame of an alcohol lamp. Instruments of steel, gum catheters, etc., may be disinfected by immersion in a five per cent. solution of carbolic acid, or in a 1 : 1000 solution of mercuric chloride. For instruments and vessels of copper, brass, and tin, boiling water, or the carbolic acid solution, may be used. Vessels of porcelain or glass may be disinfected by heat, or by either of the disinfecting solutions mentioned. Sponges should be kept permanently in one of the disinfecting solutions, or, what is better, may be dispensed with entirely for the cleansing of wounds. In place of them, irrigation with a disinfecting solution may be resorted to, or the discharges may be wiped away with some cheap absorbent material which can be burned after having been once used.

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[1] Recent experiments made by the writer make it apparent that the complete sterilization of large masses of fecal matter in privy vaults would be a difficult and expensive undertaking, if not entirely impracticable. It is therefore of prime importance that infectious material should be destroyed before it is thrown into a receptacle of this kind.

[2] Prelim. Rep. of Com. on Disinfectants, l. c.

Patients in hospitals, with infectious diseases, will of course be kept in isolated wards. Everything which comes from such a ward should be disinfected, and the immediate attendants of the sick should not be allowed to visit other parts of the hospital without first changing their outer clothing for a recently disinfected suit, and washing their hands in a disinfecting solution. When relieved from duty their underclothing should also be disinfected; and they should take a complete bath with one of the weak disinfecting solutions heretofore recommended.

Every hospital should be provided with a steam disinfecting apparatus, or with an oven for disinfection by dry heat.

*Disinfection of Water and Articles of Food.* The disinfection of drinking-water on a large scale, in reservoirs, wells, etc., is impracticable. But it is a very simple matter to disinfect water which is suspected of being contaminated with the germs of cholera, typhoid fever, or any other disease transmissible in this way. This is readily accomplished by boiling. As already stated, all known disease germs are destroyed by the boiling temperature maintained for half an hour. The importance of this precaution during the prevalence of an epidemic of cholera or of typhoid fever cannot be over-estimated, when the water used for drinking purposes comes from an impure source, or is liable to contamination by the discharges of patients suffering from these diseases. Those articles of food, and especially milk, animal broths, etc., which might serve as pabulum for disease germs, should, during the prevalence of an epidemic, be cooked but a short time before they are eaten. And such food, if put aside for some hours after it has been prepared, should always be again subjected to a boiling temperature shortly before it is served. Food which gives evidence of commencing putrefaction is unfit for use, and in time of epidemics is especially dangerous.

*Disinfection of Ships.* It should be the aim of a physician attached to a passenger ship, or of the master of a vessel having no physician on board, to prevent the vessel from becoming infected when in an infected port, or when cases of infectious disease occur on board. This is to be accomplished by keeping the ship clean; by disinfecting suspected articles, and especially the soiled clothing of passengers, before they are received on board; by the isolation of cases of infectious disease which occur on board; and by the thorough execution of those measures of disinfection recommended for the sick-room. When a case of cholera or of yellow fever occurs upon a ship at sea, it cannot be taken as evidence that the vessel is infected unless at least five days have elapsed since the person attacked came on board. For he may have contracted the disease from exposure at the port of departure, or in some other locality on shore. When, however, a longer time than this has elapsed, or when several cases develop in a particular locality on ship-board, either simultaneously or successively, the vessel must be considered infected, unless it is shown that the cases are directly due to the opening of baggage containing infected clothing.

In practice, the sanitary officials at the port of arrival usually treat a vessel as infected if any cases of infectious disease have occurred upon her during the voyage. This is a safe general rule, which should not be departed from unless a considerable time—five to seven days—has elapsed since the cases occurred, and they can be clearly traced to exposure before coming on board. In this case, if the ship is clean and the precautions relating to disinfection and isolation of the sick have been faithfully executed, the health officer may be justified in dispensing with the general measures of disinfection which are required for an infected ship.

These measures do not differ from those heretofore recommended for the disinfection of the sick-room and its contents; but the special conditions on ship-board, and the great interests at stake, make it essential that the execution of these measures should be in the hands of sanitary experts.

In the disinfection of ships, fumigation with sulphurous acid gas is a measure of prime importance, and is largely practised by those in charge of quarantine establishments. The fact that the ship may be almost hermetically closed, and the escape of gas to a great extent prevented, makes this method of disinfection more trustworthy than in the case of dwellings and hospitals. The further fact, that certain parts of the ship are inaccessible for the application of disinfecting solutions, seems to make the use of a gaseous disinfectant imperative.

Disinfection by means of steam, especially of an iron vessel, would no doubt be a difficult matter on account of the condensation which would occur from contact with the cool walls of the vessel below the water-line. But it will be well to fill the vessel with steam before introducing the sulphur dioxide; for, as already stated, the disinfecting power of this agent is much greater in presence of moisture. A well equipped quarantine establishment should have an apparatus for generating sulphurous acid gas, and injecting it into vessels, as this is the most expeditious and satisfactory method of fumigating a ship.[1]

An essential part of the disinfection of a ship will consist in the thorough cleansing of the bilge. The International Sanitary Conference of Rome prescribes that the bilge water shall be pumped out and replaced by sea water at least twice at each disinfection of the vessel. This is very well so far as it goes, but we would also recommend that after such cleansing, the potent disinfectant, mercuric chloride, be added to the clean sea-water remaining in the bilge in the proportion of one pound to the ton of water—estimated. In the case of ships sailing from ports infected with yellow fever, it would be a wise precaution, after the cleansing of the bilge at the point of departure, to throw the same amount of mercuric chloride, dissolved in salt water, into the bilge, and to add a smaller quantity of the same solution at intervals during the voyage.

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[1] The New Orleans quarantine establishment is provided with an apparatus of this kind, which seems to be well adapted for the purpose. See paper by Dr. Joseph Holt, in the annual report of the A. P. H. A. for 1884.

*Merchandise.* Article V, of the Report of the Committee on Disinfectants of the International Sanitary Conference of Rome, says,—

> "V. Disinfection of merchandise and of the mails is unnecessary. (Steam under pressure is the only reliable agent for the disinfection of rags,—*les chiffons en gros.*)"

We think this statement too broad, especially so far as merchandise is concerned which has been on board a ship infected with yellow fever. The poison of this disease seems to be capable of self-multiplication on a foul ship in tropical latitudes, quite independently of passengers and crew. And there is ample evidence that even when no case has occurred on an infected ship at sea, those who are engaged in discharging her cargo after her arrival in port may be seized with yellow fever from breathing the infected atmosphere of the hold. Evidently merchandise conveyed on such a ship should be disinfected. But it does not seem necessary to break packages which have gone on board in good condition, and a thorough fumigation with sulphurous acid gas will be sufficient if the unbroken packages are so distributed as to be fairly exposed to the action of the disinfecting agent. To accomplish this, and to effectually disinfect the ship, it will be necessary to discharge the cargo at the quarantine station.

The collections of the rag-man cannot properly be placed in the same category with other merchandise, such as agricultural products, hardware, new cotton or woollen goods, etc. An exception with regard to rags is indicated, but not stated with sufficient precision, in the article which we have quoted. There is evidence that small-pox has been not infrequently transmitted by rags, and sanitarians are generally agreed that it would be very imprudent to admit rags collected in or shipped from localities infected with cholera or yellow fever, without first subjecting them to thorough disinfection. The only practical way of accomplishing this seems to be by means of super-heated steam. To make this effective, it will be necessary to open the bales, and spread out the rags in such a manner that they may be freely exposed to the action of the disinfecting agent, or to inject the steam under pressure into the interior of the bale through perforated metal tubes, as is practised at the New York quarantine station.

## PART SECOND.

### INDIVIDUAL PROPHYLAXIS AGAINST INFECTIOUS DISEASES.

The state establishes quarantine stations, to guard against the introduction of infectious diseases of exotic origin; and in enlightened countries, sanitary officials, under the direction of the central government, or of states and municipalities, are charged with the duty of guarding the public against such diseases. It is generally recognized that this is to be accomplished by the isolation of the sick, the use of disinfectants, and by general measures of sanitary police.

One way in which the individual may indirectly protect himself against such diseases is by using his influence to have this sanitary service placed in the hands of competent men, and in sustaining them in their efforts to exclude or stamp out infectious diseases by such measures as have been demonstrated by science and experience to be efficient for this purpose.

But this is not the kind of "individual prophylaxis" which we have to consider here. The question is, What can the individual do to protect himself and those immediately dependent upon him, under the various circumstances in which he may be placed, and especially in the presence of an epidemic?

As the advice we have to give will differ greatly according to the disease, we shall pass in review the principal infectious maladies of man, and shall attempt to give for each such practical instructions as will enable an intelligent person to take all practicable precautions for his own protection, and for that of his immediate family. We have first, however, to make some general remarks.

Infectious diseases are contracted by contact with the sick, through the medium of infected articles,—"fomites,"—or by exposure in infected localities.

The evident general rule of prophylaxis is, therefore, to avoid all of these sources of infection; but there are circumstances in which this is either impossible or unjustifiable. Duty calls the physician and the nurse into the sick-room, and no argument based upon self-protection can keep the devoted mother from the bedside of her sick child, or the wife from giving her personal attention to her husband, or the husband to his wife, when stricken by pestilence. Humanity requires that during an epidemic the sick shall be cared for, the dead buried, and the foul places cleansed. All this calls for the active and intelligent efforts of persons who have the courage to face danger, and not only of those who by their profession are necessarily brought in contact with the sick,—physicians, clergymen, sanitary officials, nurses,—but often, also, of volunteers; for, during the prevalence of an epidemic of cholera, or of yellow fever, the number of physicians and trained nurses within the infected area is commonly insufficient for the care of the sick.

The history of epidemics shows that brave men and women are to be found in every civilized country, who are willing to volunteer for such perilous duties; and also that physicians, and those whose legitimate duty it is to care for the sick, very rarely desert their post in time of danger; but the mortality among these brave men and women who stand by their guns, and among the volunteers who go to their assistance, is often very great. There is a wide-spread notion among people not familiar with the facts, that doctors enjoy a certain immunity from infectious diseases not possessed by other people, and that the absence of fear is a safeguard against infection. Such a supposition is without foundation, and is an insult to the brave men and women who fall at their post of duty in every epidemic. Courage is no more a protection against disease germs than against bullets. It is true, that in epidemics, as in war, the skulkers and cowards often run into danger which the men in the ranks escape. The rashness which results from ignorance or from thoughtlessness is not courage, any more than the prudence which avoids danger when there is no good reason for facing it is cowardice. Those who rashly venture within the lines drawn by an epidemic, in the pursuit of business or pleasure, on the supposition that they will escape the prevailing disease because they are "not afraid," often fall victims to their unreasoning temerity, and not infrequently beat a hasty retreat, with blanched face, when they are brought directly into the presence of the sick and the dying.

Our advice to the brave is, Do not put your trust in your courage, for it is no armor against infection. Rely rather upon those precautions which science and experience indicate as best suited to the special circumstances in which you may be placed, and do not hesitate to retreat before an invisible foe, when you are not required by considerations of duty to remain upon the field of battle. If your services are not required, you are simply in the way; and if you fall ill, you add to the labors of those who devote themselves to the care of the sick. And to the timid we would say, Let not your fear control your actions, but look the circumstances fairly in the face, and be guided by reason and knowledge, or by the advice of those competent to decide for you. A premature flight may bring you into ridicule, or into greater dangers than those you flee from. Do not let your fears exaggerate the facts, and weigh these in the balance of your reason, and not of your apprehensions. The fact that Judge A or Col. B has fallen a victim to cholera or yellow fever is no more a reason for deserting your home, than is the fact that the humblest citizen of your town has died from the same disease.

If courage is no protection against infection, it cannot be denied that fear, in the presence of the infectious agent, is a predisposing cause which frequently determines an attack, and which may turn the balance in favor of a fatal result. The depressing effect of fear is well known, and all influences which reduce the vital resisting power of the individual predispose to an attack when an epidemic is prevailing.

Other predisposing causes of a general nature are those conditions of enfeebled resistance which result from ill-health, venereal and bacchanalian excesses, etc.

Of all these, it is probable that excessive indulgence in intoxicating drinks is the most potent factor in swelling the mortality returns during the prevalence of pestilential diseases. This predisposing cause acts in several different ways. The individual whose reason is befuddled by drink, stumbles stupidly into all kinds of danger. He is "not afraid" to sleep upon the ground, exposed to the night air, when yellow fever is prevailing, or to quench his thirst with water which a prudent man would reject as unfit to drink in the presence of cholera, or to wrap himself in a blanket which has recently been in use by a patient with small-pox. Again: the debility, often attended with digestive derangement, which follows a recent debauch, constitutes a most favorable condition for the reception of the germs of cholera, of yellow fever, and of infectious diseases generally. Those who use intoxicating drinks habitually, but within the limits marked by that mental aberration or loss of reason which constitutes intoxication, are less subject to infection than the man who is suffering from the effects of a recent "spree." But if they have any organic disease of the stomach, the kidneys, or the liver, as a result of their habits, this constitutes a predisposition to be attacked, and is a very serious complication when an attack is developed.

Persons suffering from chronic wasting diseases, profuse discharges, or recent hemorrhage, are especially liable to become the victims of an infectious disease during its epidemic prevalence. The same is true of those whose vital resistance is below par from insufficient food, or from the continued respiration of vitiated air, crowd poisoning, sewer-gas poisoning, etc.

In addition to the predisposing causes mentioned, which furnish indications of more or less value with reference to individual prophylaxis, there are individual and race differences in susceptibility to certain diseases manifested by those who are in perfect health. One man may be repeatedly exposed to an infectious disease without falling sick, while another may suffer several attacks of a disease, such as small-pox, in which one attack commonly confers immunity. Race differences in susceptibility are shown in the relative immunity of the negro from the effects of the yellow fever poison, and the great susceptibility of the same race to small-pox.

We shall now consider in detail the question of individual prophylaxis against certain infectious diseases, which, by reason of their fatality and occasional wide-spread epidemic prevalence, seem entitled to special attention in an essay of this nature.

*Cholera.* In Asiatic cholera the danger of infection from association with the sick, in the capacity of nurse or physician, is very slight. This is amply demonstrated by experience. On the other hand, laundresses, who do not come directly in contact with the sick, but who handle clothing soiled by their discharges, are liable to contract the disease. By far the greater number of cases, however, result from exposure in infected localities, and from drinking infected water. Outside of the area in India where cholera prevails as an endemic disease, localities become infected and the water-supply contaminated as a result of the introduction of infectious material from previously infected localities, either in fomites, or through the medium of the discharges of the sick. These facts furnish the indications for individual as well as for general measures of prophylaxis.

In the sick-room the precautions to be taken are, to keep the room clean and well ventilated, to disinfect the discharges of the sick and all soiled articles as promptly as possible, and to wash the hands in a disinfecting solution when they have been in contact with the patient or with soiled clothing. Attendants should not take their food in the room occupied by the sick, and should not drink liquids which have been exposed in the sick-room.

The general directions relating to diet, drinking-water, etc., which we shall shortly give, apply to the attendants upon the sick, as well as to those at a distance from them; and it should be remembered, in the interest of the sick, that these attendants do not run any special risks beyond those to which all persons within the area of infection are exposed. Indeed, we may go further, and say that they run far less risk when they are in a well regulated hospital and under intelligent supervision, than do those persons who dwell in the localities outside of the hospital from which the cases under their charge have come.

Attendants upon the sick should have their meals at regular hours, should not be deprived of a fair allowance of sleep, and should never be allowed to become exhausted by protracted vigils or excessive fatigue.

When cholera has been introduced into a country and is extending its limits from day to day, one of the first questions which will present itself to those who are able to change their place of residence will be, whether they shall attempt to keep out of its way, and if so, where it is best to go. The answer to this question must depend very much upon circumstances. Those who are unfortunate enough to live in a city or town which has a bad sanitary record, which is not provided with an efficient health department, or does not provide money to enable the officers appointed to do efficient work, had better decamp in good time, so as to evade the foe entirely, or to meet it upon a field more favorable for defensive operations. There should be no stampede, and no running away in haste, without any definite idea of why and where. The time to go is before the disease has fairly obtained a lodgment. Consider that if the season is not far advanced, and the town is in an unfavorable sanitary condition, there is every reason to anticipate that the first cases will be followed by a severe epidemic, and decide at the outset whether you will put your castle in order to stand a siege, trusting to well considered measures of individual prophylaxis, or whether you will beat a masterly retreat in advance of the first assaults of the enemy. Those who vacillate in the hope one day that the epidemic is on the decline, and in the fear the next that it will sweep everything before it, in the end very often stay, when they could just as well have gone, and at the same time neglect those precautions which they should have taken at the outset if they had decided to stay.

To those who are unable or unwilling to desert their homes, we would say, that when proper precautions are taken the danger is really not very great, and that sanitarians look for the day when cholera will be practically banished from civilized countries. See that your premises are in good sanitary condition, and do what you can to induce your neighbors and the authorities in your town to prepare for the storm. Look especially after the plumbing of your houses, and if there is a cesspool or a privy vault upon your premises, see that it is kept in good condition by the use of antiseptics and deodorants.[1] Above all, be sure that no food comes into your house except such as is sound and good, and that the drinking-water used by your family is beyond suspicion. Well-water is always open to suspicion, and in general, during the prevalence of cholera, it will be advisable to *boil all water used for drinking purposes*. This is a prophylactic measure of prime importance, and there is good reason to believe that if faithfully executed it would, to a great extent, limit the ravages of the Asiatic pestilence. Tea and coffee recently made can be taken with impunity. Milk, during the prevalence of an epidemic, should be boiled before it is used as food. Mineral waters, if bottled at places distant from the infected area, may be drunk in moderation. A moderate amount of sound wine, which was bottled prior to the epidemic, may be permitted to those who are in the habit of using it. Those not in the habit of using stimulants should not resort to their use during the progress of an epidemic. Those accustomed to them should restrict their libations within moderate limits, and will find a little brandy and soda, or Appolinaris water, to be better than wines, and especially than the acid wines, which are apt to derange the digestion.

Food should be plain and well cooked, and should be taken in moderate quantities. Intemperance in eating is quite as bad as intemperance in drinking. Soups, meats, and vegetables should always be served hot, and should not be put aside for a future repast, or, if served a second time, should be brought to the temperature of boiling water shortly before they are eaten. Pastry and rich puddings, and all coarse and indigestible meats and vegetables, are to be avoided. Sound, ripe fruit, which has been brought to the house with the outer skin unbroken, may be eaten in moderation by those who know by experience that it agrees with them. It should be carefully washed before it is eaten. Melons, cucumbers, unripe apples, peaches, or pears, acid fruits generally, and, in short, all those articles which are known to give rise to digestive derangements in the absence of cholera, would better be banished from the supply-list during the prevalence of this disease.

Next to the precautions relating to food and drink, we would place those relating to personal habits and clothing. The bowels should not be allowed to become constipated, and, on the other hand, any tendency to diarrhœa should at once receive attention. This is a matter of the greatest importance, and, indeed, is second to none other in individual prophylaxis. Absolute rest, a light diet, and a dose or two of chlorodyne, or of Hope's mixture, or of any approved combination of an opiate and an astringent, will usually suffice to control a slight diarrhœa, even if it is of a choleraic character.

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[1] See Part First of this essay for details relating to the use of these agents.

The clothing should be suited to the season, but great care must be taken that it is warm enough at all times to prevent the body from becoming chilled. A broad flannel belt worn about the abdomen is recommended by some physicians of experience, and may be useful. Baths should be taken at frequent intervals, but should not be too prolonged or too cold, and should be followed by a vigorous rubbing of the surface, to establish reaction. Excessive exercise and fatiguing labor of all kinds are to be avoided. One should never feel "done up," as a result of his exertions in the way of business or of pleasure, for the lassitude resulting from over-exertion, like that which results from fear, predisposes to an attack. Mental depression is, so far as possible, to be avoided: grief, despondency, and "carking care" are recognized as predisposing causes in cholera and in other infectious diseases.

The use of "sulphuric acid lemonade"—that is, of pure water acidulated with this acid and sweetened to taste—has been recommended as a prophylactic, and there is some evidence in favor of its usefulness. We would not advise its indiscriminate use, or that of any other prophylactic of this nature. When cholera has made its appearance in a dwelling or in a public institution, the inmates may be given this, to the exclusion of all other drinks.

*Yellow Fever.* This disease, like cholera, is contracted in infected localities, rather than by contact with the sick. Indeed, it is rarely, if ever, communicated directly by a sick person to his attendants. In infected places the poison seems to be given off from the soil, or from collections of decomposing organic matter, and we have no definite evidence that it is communicated through the medium of food or drinking-water. The history of epidemics of this disease shows that when it obtains a lodgement in a city or town which is in an insanitary condition, in southern latitudes and during the summer months, it extends its area and invades new localities similarly situated, until frost occurs, or at least until the weather becomes comparatively cool in the autumn. Those who remain in an infected area, unless protected by a previous attack, are almost certain to contract the disease, and much less can be done in the way of individual prophylaxis than in cholera. We therefore advise all those who can get out of the way of this dread disease to do so. As a rule, there will be plenty of time, after there is evidence that the disease has established itself in certain parts of a city, for those who live at a little distance from these centres of infection to get away in a deliberate and well considered manner. The occurrence of one or more imported cases cannot be taken as evidence that an epidemic will follow, and is no reason for deserting one's home. If proper precautions are taken by the sanitary authorities, it is very probable that no epidemic will follow such importation of the disease. [illegible] the occurrence of other cases [illegible] have been [illegible] or when such local cases occur in the vicinity of the wharves where vessels from infected ports discharge their cargoes, or in sailors' boarding-houses, etc., it must be taken as evidence that the disease has effected a lodgement, and that infected centres have been established, from which an epidemic will in all probability be developed, if the season is favorable and the city in an insanitary condition.

An epidemic is not developed so rapidly as in the case of cholera, but the disease usually extends its limits in a very deliberate way, and while it is claiming its victims in one section of a city, other sections in the immediate vicinity may be quite healthy. But the territory invaded remains infected until cold weather puts an end to the epidemic. Frequently it happens that no new cases occur in an infected area for several weeks, or even months, for the simple reason that all those who remained to do battle with the pestilence have suffered an attack or are protected by a previous attack. The epidemic has ceased for want of material, but the infection remains, and will manifest itself if unprotected persons venture within the infected area from a mistaken idea that there is no more danger because there are no longer any cases.

In this disease, then, the most important point in individual prophylaxis is to keep away from infected localities, and from those places where the disease is epidemic,—*e. g.*, Havana, Vera Cruz, Rio Janeiro,—during the season of its prevalence. Very many lives have been sacrificed by a misplaced confidence in the protection which courage is supposed to afford against this disease. "I am not afraid," says the merchant whose business calls him to an infected city, or the sea-captain who wishes to obtain a cargo of sugar in Havana during the summer months. But not being afraid does not prevent such persons from being attacked, and the mortality at Havana among sailors from northern latitudes is very great. There is a tendency in places where the disease is endemic to underrate its malignity, and to ascribe every fatal case to some fault on the part of the unfortunate victim or his attendants. He was "frightened to death," or "was not properly nursed," or he was "imprudent," etc., etc. The mortality is no doubt largely influenced by these secondary causes, but yellow fever is a malignant disease, which under the most favorable circumstances is very fatal to unacclimated strangers within the limits of its endemic prevalence, and which in its epidemic extension in new territory claims from 30 to 50 per cent., or even more, of those who fall sick, as its victims. This being the case, we repeat our advice to all those whose duty does not require them to stay on the field of battle, to make an orderly retreat to some place of safety.

The precautions relating to food and to personal habits do not differ materially from those recommended in the case of cholera. The diet should be simple, and excesses should be avoided. Less care will be necessary with reference to the use of fruits and vegetables;—indeed, they are rather to be recommended, as better suited than animal food to the warm latitudes in which this disease prevails. Constipation should, above all things, be avoided; and if there is evidence that the functions of the liver or kidneys are imperfectly performed, suitable medication should be resorted to.

There is no special danger from the use of water, if it is from a source which ensures it from contamination with organic impurities. Spirituous liquors, if used at all, should be taken in great moderation. Nothing is more likely to develop an attack than alcoholic excesses, and the habitual drunkard is almost doomed to death if he falls sick with this disease. Exposure to the direct rays of the sun, excessive fatigue, and venereal excesses are all predisposing causes which it is within the province of individual prophylaxis to avoid. Exposure to the night air, and especially sleeping out of doors near the ground, is recognized by experienced physicians in yellow fever regions as an invitation to an attack. Great care should be taken to avoid chilling of the body, and it is well to sleep as far from the ground as possible. The creoles of Louisiana and of the West Indies generally insist upon closing the windows of a sleeping-room at night.

The mortality among natives of tropical climates, and especially among those whose habits are good, and who are accustomed to a frugal mode of life, is very much less than among the natives of northern latitudes, when these come, without any previous "acclimation," within the influence of the yellow fever poison. Those who are habituated to life in the extreme South enjoy a certain immunity from the effects of the poison, which is shown by a lower death-rate rather than by any exemption from being attacked. One attack of this disease, as a rule, confers immunity from a subsequent attack.

Individual prophylaxis in an infected city will include the avoidance of those localities which give special evidence of being infected, and especial care not to visit such localities at night.

The liberal use of disinfectants in cesspools and water-closets, and a perfect state of sanitary police in and around the premises, will constitute a most important part of the precautionary measures which every individual should take for his own protection and that of his family. A state of mental equilibrium, and an intelligent appreciation of the special circumstances in which he is placed, and of the various measures of prophylaxis heretofore indicated, will enable an individual to look the facts fairly in the face, and to be governed by the light of reason and of science. Unfortunately it too often happens, among the ignorant and degraded, that a spirit of bravado, attended with a neglect of the simplest sanitary precautions, and a disposition to deny the presence of the dreaded foe, prevails during the earlier stages of an epidemic, and that this is followed by a disorderly stampede and a disgraceful neglect of the sick, when the presence and malignant nature of the pestilence are recognized.

*Small-Pox.* This disease is contracted by exposure to emanations from the body of the sick, or from articles which have been in use by them, or exposed in their vicinity. There is no evidence that the small-pox poison multiplies external to the human body, and the indications for prophylaxis are therefore quite different from those already given for cholera and yellow fever. One may eat what he pleases, and wallow in filth, when small-pox is prevailing, without contracting the disease, so long as he keeps away from the sick, and is not brought in contact with any article infected by them. In this disease, however, as in the infectious diseases generally, previous personal habits will greatly influence the result when exposure does occur; and the disease is more fatal to the victims of alcoholism, to those who are poorly nourished, and, in general, to those whose vitality is reduced by exposure to noxious effluvia from putrefying material, by living in overcrowded and ill-ventilated apartments, etc.

As it is now the universal practice to isolate small-pox patients as soon as the disease is recognized, the danger of coming, accidentally, in contact with them is not great. There is but little danger of infection from passing within a few yards of a patient with small-pox in the open air, or from passing a building in which cases are under treatment. Unprotected persons who enter the sick-room are, however, extremely liable to contract the disease; and the infectious material given off from the patient's body clings most tenaciously to surfaces, to clothing, etc., and may give rise to an attack after many months, unless destroyed by disinfection.

It is evident, then, that individual prophylaxis will include the avoidance of places which have been occupied by the sick, and of articles used by them, unless there is a certainty that they have been thoroughly disinfected. It is probable that an unprotected person, who feels obliged, for special reasons, to enter the sick-room, may escape infection by the use of an air filter placed over the mouth and nostrils. This should be constructed on the principle of the "Tyndal respirator," in which all inspired air is made to pass through a layer of cotton wadding, which arrests suspended particles. It would be necessary immediately on coming out of the room to burn the cotton filter, to bathe the hands and face in a disinfecting solution, and to change the outer clothing.

It is a general rule in regard to infectious diseases that those who are necessarily exposed to them should take the precaution of not going into the sick-room with an "empty stomach," or in a condition of exhaustion from any cause. A cup of coffee, or a glass of wine and a cracker, may be taken if a considerable interval has elapsed since the last regular meal.

It is well known that against small-pox we have a special measure of prophylaxis, which has restricted the ravages of this disease within the limits which are left to it by carelessness in regard to the application of this measure, or ignorance of its value. Since the famous discovery by Jenner, vaccination has become the prophylactic *par excellence*.

The immunity conferred by vaccination is, as a rule, complete; but there are exceptions to this rule, and vaccinated persons occasionally suffer from a modified form of the disease. The statistics of the London small-pox hospital show that the mortality among unvaccinated persons received into that hospital with small-pox, is 35.55 per cent.; while the mortality among vaccinated persons is less than 7 per cent. No doubt a large portion of the cases of post-vaccinal small-pox might have been prevented by revaccination.

It is now recognized that the protective influence of vaccination is not always of a permanent character, and children who have been successfully vaccinated in infancy should be revaccinated when they reach the age of puberty, or sooner, if small-pox is prevailing in the neighborhood. The operation is so trifling that it is customary to vaccinate old and young, with the exception of those who have been successfully vaccinated within a year or two, whenever an outbreak of small-pox occurs. This practice is to be recommended, but when the operation has been performed in a proper manner, with virus which is known to be reliable, it is folly to insist upon a frequent repetition of the vaccination, because "it didn't take." If the first vaccination has been completely successful, a *perfect* result from revaccination is not usually obtained; and the fact that no result is obtained must be taken as evidence that the person is protected. The prophylactic value of vaccination practised after exposure to small-pox has been demonstrated, and one who is not entirely certain that he is protected by a recent successful vaccination will do well to resort to this important prophylactic measure at once, if he has reason to suspect that he has been exposed to small-pox.

*Scarlet Fever.* In this disease, as in small-pox, the poison is given off from the bodies of the sick, and is not reproduced independently of them. As we have no knowledge of any means of protection corresponding with vaccination, prophylaxis consists solely in keeping out of the reach of infection by the sick, or by articles infected by them.

The sick person may communicate the disease during the whole period of his illness and convalescence,—a period which often extends to five or six weeks, or even longer than this. Infected clothing, which has been packed away for months, may communicate the disease; and there are numerous instances on record of its transmission to children at a distance from the sick, by healthy persons who have recently come in contact with scarlet fever patients. The lower animals, and especially pet cats and dogs which may have visited the sick-room unnoticed, or which are thoughtlessly given to convalescent children for their amusement, constitute a great source of danger. Persons who have suffered an attack of the disease, or who have but little susceptibility to it, may have a slight sore throat as a result of exposure to the scarlet fever poison, and may communicate the disease in its more severe form to unprotected children. One great difficulty in arresting the progress of an epidemic by isolation of the sick and disinfection, results from the fact that these slight and often unrecognized cases are frequently allowed full liberty.

Infection has been traced to milk which had been standing in the sick-room, or to the same liquid which had become infected at a dairy where scarlet fever had prevailed, and where recent convalescents were permitted to milk the cows.

All of these facts point to a most rigid exclusion of susceptible children from every possible source of infection. The susceptibility of adults is very much less, and, when attacked, they usually have the disease in a mild form. But their responsibility extends far beyond the point of avoiding the sick for their own protection. Those who are associated with susceptible children have no right under any circumstances to visit the room of a scarlet fever patient without taking the most thorough precautions with regard to the disinfection of their person and clothing immediately upon leaving it; and even with these precautions, such a visit cannot be justified when it is made simply out of curiosity or friendship. Only those who are in attendance upon the sick should be allowed in the sick-room, and they must be regarded as infected persons, who are not to be permitted to come in contact with unprotected children while they are engaged in this duty.

*Diphtheria.* This is a disease in which the infectious material is given off from the surfaces affected, and probably not from the general surface of the body. As the usual seat of the disease is the throat and the nasal mucous membrane, it is the discharges from these surfaces which are especially dangerous. Although adults are much less susceptible to the disease than children, there have been numerous instances in which they have contracted diphtheria by the accidental reception of a bit of infectious material directly into the fauces. This is especially liable to occur during the operation of tracheotomy; and several physicians have lost their lives in this way, in their efforts to save those of their patients by aspirating through the tracheotomy tube. It seems extremely probable that the diphtheretic poison—germ—is capable of increase, independently of the sick, in damp, foul places, such as sewers, damp cellars, and especially under old houses in which the floors come near the surface of the ground, leaving a damp, ill-ventilated space. At all events, the disease often clings to such houses in spite of the application of the usual means of disinfection. There is no doubt as to the influence of bad hygienic conditions in maintaining the infection when the disease has been introduced, and it is possible that such conditions may, in certain cases, originate it.

Insufficient nourishment, the malarial poison, and insanitary surroundings are predisposing causes to the disease. Those suffering from scarlet fever, measles, whooping-cough, and tuberculosis are also especially liable to be attacked. As in the case of scarlet fever, mild cases, which in the absence of others more pronounced it would be difficult to recognize as due to the diphtheretic poison, may give rise to malignant diphtheria in more susceptible individuals, or in those whose vital resisting power is reduced by any of the causes mentioned.

Prophylaxis will demand complete non-intercourse with the sick, avoidance of infected localities, and care to exclude all persons and articles coming from such houses from contact with yourself or children. The disease is often spread by thoughtless persons who visit the sick-room, and even kiss the infected patients, and then, without any precautions in the way of disinfection, fondle healthy children in other places, and perhaps transmit by a kiss the infectious material which has adhered to their lips. The possibility of transmission by pet animals is also to be borne in mind.

*Tuberculosis.* Recent researches have demonstrated that tubercular consumption is an infectious disease, and that the sputa of those affected with it, injected into susceptible animals, reproduces in them the same disease. This sputum is therefore infectious material, and should be destroyed by burning, or by the use of chemical disinfectants. There would be little danger of infection from the moist masses of sputum, but in a desiccated condition this material is liable to reach the lungs of susceptible individuals, and to induce the disease.

It is well known that there is a great difference in susceptibility to pulmonary consumption, and that in certain families this disease carries off one member after another, while it is unknown in other families. Those who have this hereditary predisposition should pay special attention to individual prophylaxis. They should avoid intimate association with consumptive persons, should live under the best hygienic conditions, in dry, well ventilated apartments, and should select an occupation which will keep them in the open air, rather than one which keeps them confined to the house. Above all, they should avoid the respiration of an atmosphere loaded with organic impurities, or with irritating inorganic particles—dust of various kinds. Out of door life on the high and dry plains in the centre of the continent, or in the mountains, will in most instances enable them to overcome the predisposition, if commenced before infection and the resulting tubercular lesions have occurred.

Those who are engaged in occupations which require them to pass some hours each day in an atmosphere loaded with dust will do well to wear a respirator for filtering the suspended particles from the air; for it is demonstrated that, independently of hereditary predisposition, the respiration of such an atmosphere predisposes to tubercular disease of the lungs.

*Typhoid Fever.* In this disease, as in cholera, the infectious agent is contained in the alvine discharges of the sick. In the interest of self-preservation as well as in that of the public good, every individual who has charge of cases should see that the evacuations from the bowels are thoroughly disinfected before they are thrown out.

The drinking of water contaminated with such infectious discharges is recognized as a very frequent mode of infection; and individual prophylaxis demands an intelligent consideration of the source from which a supply of drinking-water is obtained for personal or family use. If there is the least reason to suspect that this supply may be contaminated by typhoid material, or if it contains an undue amount of organic impurities, it should be rejected entirely, or boiled shortly before it is used.

Typhoid epidemics have in several instances been traced to using milk which had been contaminated by infected water, added to it directly, or used at the dairy to wash the vessels containing it. The remedy in this case is to verify the purity of the source of supply of all milk used for drinking, or to boil it immediately before it is used.

The water of wells located within the limits of a city or village should not, as a rule, be used for drinking purposes, for the soil is almost certain to be polluted; and it often occurs that the contents of privy vaults and cesspools pass into the same porous stratum of sand or gravel from which the well-water is obtained, or that surface drainage finds its way into shallow wells. It will be necessary, also, to regard with suspicion the water of small streams and ponds which are so situated that they may receive the drainage from collections of filth upon their margin.

Next to impure water we must place impure air as a factor in the etiology of typhoid fever. There is good reason to believe that the germs of the disease may be carried by the foul gases which are given off from sewers, privies, etc., when these become infected, and that the disease may be induced by the respiration of such a contaminated atmosphere. At all events, the breathing of a vitiated atmosphere, and insanitary surroundings generally, constitute predisposing causes which should be avoided.

In typhoid fever, as in yellow fever and cholera, depressing mental emotions, such as grief, despondency, or fear, and physical exhaustion from excessive fatigue, insufficient food, etc., are predisposing causes which may induce an attack in the presence of the infectious agent.

*Concluding remarks.* This chapter might be greatly extended, but, having passed in review the principal measures of individual prophylaxis against those infectious diseases which are most fatal, we shall not dwell upon precautions to be taken in other contagious diseases, such as measles and whooping-cough. These precautions will not differ from those already recommended in the cases of small-pox and scarlet fever. So, too, in regard to the infectious skin diseases. These are communicated by personal contact, and rarely occur except among those who neglect personal cleanliness, as well as other sanitary laws. Soap and water will generally suffice for individual prophylaxis. By avoiding filthy persons as well as filthy places, the danger of contracting these and certain other unmentionable infectious diseases will be reduced to a minimum.

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